# Widespread slow slip events triggered at the Hikurangi subduction zone by the M7.8 Kaikoura earthquake, New Zealand

*Laura M Wallace[1], Yoshihiro Kaneko[2], Elisabetta D'Anastasio[2], Sigrun Hreinsdottir[2], Noel Bartlow[3], Bill Fry[2], Zhigang Peng[4], Ian Hamling[2], Matt Gerstenberger[2]

1. GNS Science and University of Texas Institute for Geophysics, 2. GNS Science, 3. University of Missouri, 4. Georgia Tech

Just after midnight on 14 Nov 2016 (NZ Local time), the M7.8 Kaikoura earthquake ruptured a complex sequence of strike-slip and reverse faults over an approximately 150 km length in the northeastern South Island of New Zealand (Hamling et al., in review). Immediately following the earthquake, continuous GPS sites operated by GeoNet (www.geonet.org.nz) along the North Island’ s east coast (above the Hikurangi subduction zone) detected several to 30 mm of eastward motion over the two-week period immediately following the M7.8 event. These sites are located 350-650 km from the M7.8 earthquake. Such large eastward motion along the North Island’ s east coast following the earthquake is consistent with the initiation of a large slow slip event along the shallow, offshore portion of the Hikurangi subduction zone. The largest SSE slip is observed offshore the southern Hawkes Bay region (~10 cm), and was accompanied by abundant seismicity in the SSE region, with numerous events in the Mw 2.0-5.0 range, and as high as Mw 6.0. In addition to shallow slow slip (<15 km depth) triggered offshore the east coast, we also observe deeper slow slip (>30 km depth) triggered in the Kapiti region at the southern Hikurangi margin, as well as afterslip on the subduction interface beneath the northern South Island beneath the region of large coseismic slip on crustal faults in the M7.8 earthquake. This observation of slip beneath the northern South Island is the first strong evidence that the far southern end of the Hikurangi subduction zone does indeed accommodate plate motion and undergoes slip, in contrast to the widely held assumption that the plate interface there is “permanently locked”.

Given the large distance of the shallow east coast SSE from the M7.8 earthquake, we suggest that the shallow SSE was more likely to be triggered by dynamic stress changes, while the deeper SSEs closer to the Mw 7.8 were more likely triggered by static stress changes. We show that dynamic stresses induced in the shallow (east coast) SSE source were on the order of 200-700 kPa, which is 1000 times higher than static coulomb stress changes (0.2-0.7 kPa) induced in the SSE source region by the earthquake. The large magnitude and immediate onset of the SSE following the earthquake, long distance from the M7.8 earthquake, and the broad regional extent arguably makes this the clearest example ever documented of large-scale dynamic triggering of slow slip. We show that dynamic stress changes will be largest on the shallow portion of the subduction interface (<10 km) where it is overlain by low velocity sediment, demonstrating that large-scale shallow SSEs may be more easily triggered by dynamic stress changes compared to deep SSEs. We also discuss the role that the triggered slip events may play in the future likelihood of megathrust earthquakes at the Hikurangi margin.

Keywords: subduction , slow slip event, earthquake

 